

# PATENT SPECIFICATION

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## (54) A FLEXIBLE PIPE WITH TERMINAL COUPLINGS

(71) We, SOCIETE SUPERFLEXIT, a Societe Anonyme organised under the laws of France, of 45, rue des Minimes, 92400 Courbevoie, France, do hereby declare the invention, for which we pray that a Patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to a flexible pipe having a terminal coupling at each end.

The pipe, which may or may not be reinforced by braids or layers of fibres or folds of textile material previously stuck together and wound in the form of a spiral, has a tube part of semi-conducting material (as hereinafter defined).

When such flexible pipes are used to carry inflammable liquids able to be charged with static electricity, experience shows that it is necessary to keep the electrical resistance (measured between the two couplings) between two values depending on the length of the flexible pipe, these values being fixed for example at  $10^4$  and  $2 \times 10^6$  ohms per metre by French regulations.

The expression "semi-conducting material" used herein and in the appended claims means an electrically conducting compound comprising electrically insulating elastomeric or plastomeric material containing electrically conducting powder.

It is known to use pipes formed of elastomeric or plastomeric materials which are naturally insulating and can be made more or less conductive solely by using conducting powdery products, in particular carbon blacks which are so called "conductors". Metallic powders or conducting metal oxide powders are also used, but less frequently and with limited effectiveness.

In all cases, the intrinsic resistivity obtained varies over a period of time depending on the tensile, bending or twisting forces which are exerted on the

pipe wall of elastomeric or plastomeric material and consequently it is very difficult to guarantee the resistance of a flexible pipe since it can vary at any instant.

The present invention relates to a flexible pipe which makes it possible to remedy or at least mitigate these drawbacks.

According to the invention there is provided a flexible pipe having a terminal coupling at each end, said pipe comprising an inner tube surrounded along its length by an outer tube, at least one of said tubes being made of semi-conducting material (as hereinbefore defined), an electrical conductor member of low resistivity extending along the length of the pipe in direct electrical contact with a said tube made of semi-conducting material connected to the terminal couplings, and the conductor member being separated from the couplings and having no direct contact with said couplings.

Electrical connection between the terminal couplings is established through the conducting member and portions of semi-conducting material in contact with the couplings at each end of the pipe.

At least the inner or the outer tube is made of the semi-conducting material.

The conducting member, which is of low resistivity, is in electrical contact along its length with the tube of semi-conducting material. The conductor member extends along the length of the pipe and can be disposed between the inner and outer tubes.

The conductor member can be formed by one or more metal wires, and may, for example, be formed by braided strands of wire. The conductor member formed by a layer of wires or a braid of wires may reinforce the pipe.

If desired, the conductor member can be in the form of a spiral about the inner tube, or the conductor member may extend along a generatrix of either tube.

The conductor member may be integrated with reinforcing braid disposed around the inner tube.

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If desired both tubes can be made of semi-conducting material.

At each end of the pipe a ring of semi-conducting material may be interposed between an end of the terminal coupling and the conductor member.

In the case, for example, where the conductor member is metal braid, the electrical resistance is the sum of the resistance of the braid whose electrical resistance has a low and stable value and of the resistances of the two rings of semi-conducting material between the braid and the end of the couplings at the extremities of the pipe. On account of the assembly of the couplings, these rings of elastomer or plastomer are not subject to any tensile, bending or twisting force during the use of the flexible pipe and thus maintain a constant electrical resistance. The result of this arrangement of the flexible pipe is that its overall resistance is substantially constant.

Even in the case of rupture of the braid at one point or several points of its passage through the pipe, the resistance of the latter remains substantially constant.

The invention will now be further described, by way of example, with reference to the accompanying drawing in which:

Fig. 1 is a perspective view, partly in section, of a fragment of one embodiment of a pipe formed according to the invention, and

Fig. 2 is a view, partly in longitudinal section, of one of the ends of the pipe in Fig. 1 in combination with a terminal coupling.

The pipe in Fig. 1 comprises a flexible inner tube 1 of semi-conducting material made of either elastomer or plastomer, containing a certain percentage of conducting carbon black in order to obtain a certain electrical conductivity.

At least one flexible member 2 which is a conductor of electricity and of low resistivity is wound in the form of a spiral on the tube 1 as shown in Fig. 1. The conductor member 2 is bare in the sense of not being covered by insulation and extends along the length of the pipe so that each successive point along the conductor member is in electrical contact with the tube 1 along the whole length thereof. In Fig. 1 the conductor member 2 is constituted either by a single metal wire or by a metal braid formed by a plurality of strands of wire. The conductor member 2 may be integrated in a reinforcing braid 3 of textile fibres placed on the tube 1, or the conductor member and braid 3 may not be integrated.

The reinforcing braid 3 is covered by a second textile braid 4 or layer of strips of fabric previously stuck together and

forming a tubular shape around the tube 1. About the whole, an outer flexible covering tube 5 of insulating elastomer is placed.

The flexible pipe constituted in this way, which comprises in its central part, a conducting braid 6 constituted by one or more conductors of electricity (conductor members) and textile braids 3, 4 is provided at each of its ends with a terminal coupling 7 (only one shown) comprising a screw-threaded part 7a intended to be screwed into a corresponding tapped hole in another connecting member. The coupling 7 has a socket 7b which is engaged inside the end of the pipe and cooperates with a ring 8 located at the end of the pipe in order to retain the end of the pipe between the said socket 7b and the ring. The ring 8 has a collar 8a which is retained between the coupling 7 and the end face of the pipe.

The conductor member(s) extend between the socket 7b and the ring 8 but does not/do not contact the socket or ring. At its end 2a, the conductor member 2 is separated from the collar 8a by a ring 9 of semiconducting or insulating material interposed between the conductor member and the collar 8a or end of the terminal coupling.

In another embodiment, the tubular member 1 is made of insulating material and the outer covering tube 5 is made of semi-conducting material such that the conductor member 2 is in direct contact with the outer tube 5. As previously, the electrical conductor member 2 has no direct contact with the couplings 7.

It is also possible to produce the pipe using inner and outer tubes which are both made of semi-conducting material, the electrical conductor 2 remaining between them.

In the various embodiments, the electrical connection from one terminal coupling to the next passes through the layer of semi-conducting material forming the tube 1 and/or 5 in contact with the couplings 7 and the electrical conductor member 2, the conductor member having no direct contact with the couplings.

#### WHAT WE CLAIM IS:—

1. A flexible pipe having a terminal coupling at each end, said pipe comprising an inner tube surrounded along its length by an outer tube, at least one of said tubes being made of semi-conducting material (as hereinbefore defined) an electrical conductor member of low resistivity extending along the length of the pipe in direct electrical contact with a said tube made of semi-conducting material connected to the terminal couplings, and the conductor member being separated

from the couplings and having no direct contact with said couplings.

5 2. A pipe as claimed in claim 1, in which the conductor member is in the form of a spiral around the inner tube made of semi-conducting material.

10 3. A pipe as claimed in claim 1, in which the conductor member extends along a generatrix of the inner tube made of semi-conducting material.

4. A pipe as claimed in any one preceding claim, in which the conductor member is integrated in reinforcing braid.

15 5. A pipe as claimed in claim 1, in which the conductor member is metal wire.

6. A pipe as claimed in claim 1, in which the conductor member is formed by a plurality of braided strands of metal wire.

20 7. A pipe as claimed in claim 1, in which the conductor member is in the form of a spiral under and in direct electrical contact with the outer tube made of semi-conducting material.

25 8. A pipe as claimed in claim 1, in which the conductor member is disposed under and in direct electrical contact with the

outer tube made of semi-conducting material, and the conductor member extends along a generatrix of the outer tube.

9. A pipe as claimed in claim 1, in which the conductor member is a braid of metal wires or a layer of metal wires reinforcing the pipe. 30

10. A pipe as claimed in any preceding claim, in which at each end of the pipe a ring of semi-conducting material (as hereinbefore defined) or insulating material is interposed between the conductor member and an end of a said terminal coupling. 35

11. A flexible pipe having a terminal coupling at each end, substantially as hereinbefore described with reference to the accompanying drawing. 40

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COMPLETE SPECIFICATION

1 SHEET

*This drawing is a reproduction of  
the Original on a reduced scale*

FIG. 2

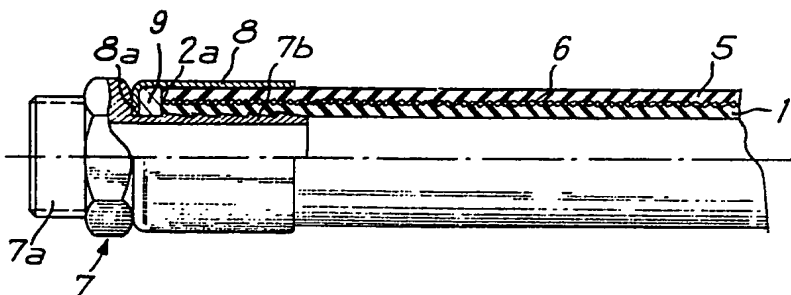


FIG. 1

